MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2018/2019

EEE1046 – ELECTRONICS III

(All sections / Groups)

31 MAY 2019
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages (including the cover page) with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

a) List **FIVE** (5) essential characteristics of an ideal operational amplifier (op-amp). [5 marks]

b) An ideal op-amp circuit with feedback resistors $R_{F1} = R_{F2} = 100$ kΩ, input resistor $R_a = 10$ kΩ and load resistor $R_L = 5$ kΩ is shown in Figure Q1. The input DC voltage is given as $V_{in} = 10 \sin\omega t$ V.

(i) Is it an inverting or non-inverting op-amp? Explain your answer. [2 marks]

(ii) Show that V_{out} is expressed as:

$$V_{out} = -\left(\frac{R_{F1} \times R_{F2}}{R_{F1} + R_{F2}}\right)\frac{V_{in}}{R_a}$$

[5 marks]

(iii) Determine the output voltage V_{out} and current I_{out}. [2 marks]

(iv) Calculate the voltage gain for this op-amp. [2 marks]

(v) Can a small value of R_L use in this op-amp? Justify your answer. [3 marks]

(vi) Determine the current I_{F1}, I_{F2} and I_{Ra}. [4 marks]

(vii) Suggest a usage for this op-amp if $R_{F1} = R_{F2} = 2R_a$. [2 marks]

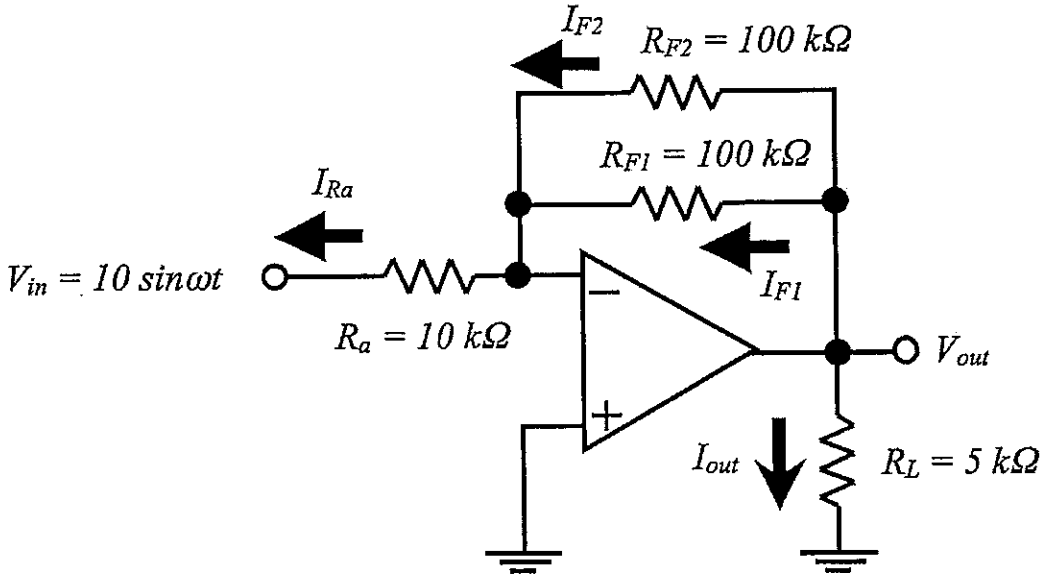

Figure Q1

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Question 2

a) List **FIVE** (5) problems that occurred in a real-world op-amp.

[5 marks]

b) An op amp with input offset Voltage, V_{IO} and input offset current, I_{IO} is shown in Figure Q2. The input and output voltages are V_{in} and V_{out} respectively. The final output signal after going through a coupling capacitor is V_{out_C}.

(i) Explain briefly with suitable diagrams, the meaning of input offset voltage and output offset voltage in a real world op amp.

[8 marks]

(ii) Derive the expected voltage at the output, V_{out} in terms of V_{in}, V_{IO}, R_a and R_F, by considering ONLY the input offset voltage (V_{IO}).
[*Hints* : Set $I_{IO} = 0$ and $V_+ = V_- = V_{IO}$]

[4 marks]

(iii) Derive the expected voltage at the output, V_{out} in terms of V_{in}, V_{IO}, I_{IO}, R_a and R_F, by considering BOTH the input offset voltage (V_{IO}) and the input offset current (I_{IO}).
[*Hints* : Set $I_{Ra} = I_F + I_{IO}$ and $V_+ = V_- = V_{IO}$]

[4 marks]

(iv) IF $V_{in} = 10\ Sin\omega t$ mV, $V_{IO} = 5$ mV and $I_{IO} = 1$ μA respectively, determine the expected voltage at the output, V_{out} with BOTH the input offset voltage and input offset current.

[2 marks]

(v) What is the voltage at the output after going through a coupling capacitor, V_{out_C}?

[2 marks]

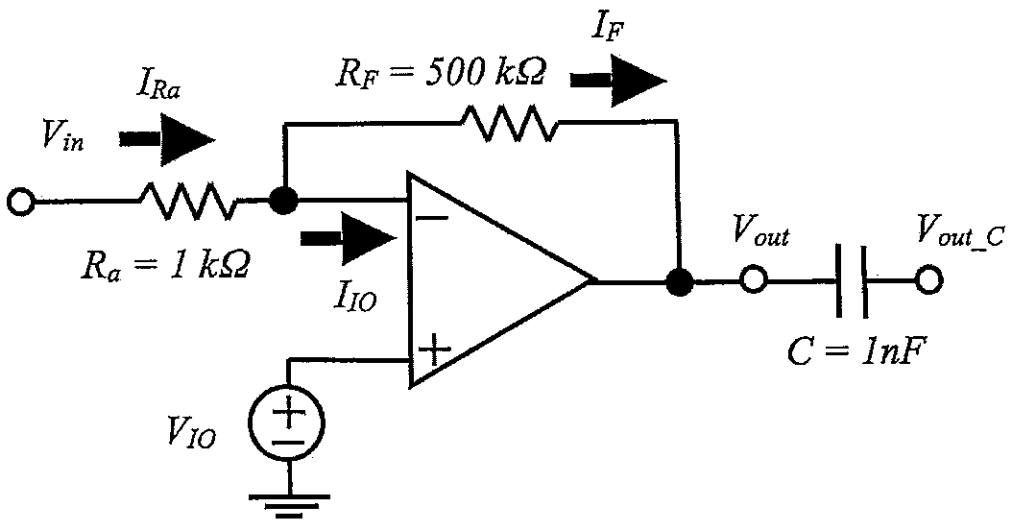

Figure Q2

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Question 3

a) Figure Q3 (a) shown a series feedback voltage regulator. Given $V_S = 20V$, $R_1 = 35$ kΩ, $R_2 = 90$ kΩ, h_{FE} of the transistors is 150 and V_{BE} of the transistor is 0.7 V. Determine the following:

(i) Given the regulated output voltage, $V_o = 10V$, determine V_Z. [3 marks]

(ii) Assume half of Zener current I_z sources from resistor R. If Zener operating current, $I_z = 12mA$, determine R value. [3 marks]

(iii) Determine the total I_{C1}, if $R_L = 80\ \Omega$ and ignore I_{B2}. Assume $I_{C1} = I_{E1}$. Then determine I_{B1}. [4 marks]

(iv) Determine R_3. Assume $I_{C2} = I_{E2}$. [4 marks]

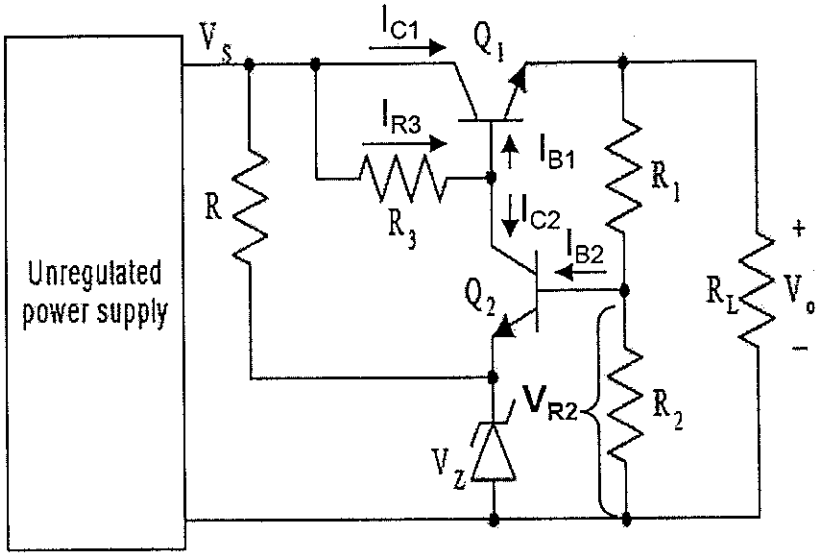

Figure Q3 (a)

b) A waveform generated from a square ware generator is shown in Figure Q3 (b). The v_o is the output of Schmitt Trigger (or a comparator).

(i) Sketch the circuit diagram of Square Wave Generator. Label the circuit with the correct parameters indicated from the waveform. [4 marks]

(ii) Design a square wave generator with 30 kHz oscillation frequency, and threshold voltage $|+V_{th}| = |-V_{th}| = 4V$, $|+V_{sat}| = |-V_{sat}| = \pm 12V$. Given $R_F =$ 10 kΩ and $R = 5$ kΩ. [7 marks]

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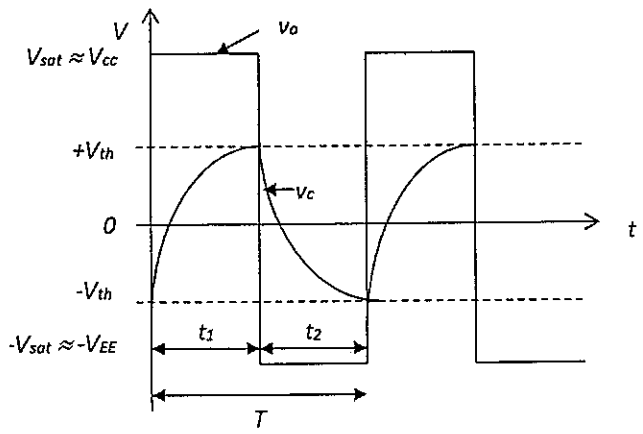

Figure Q3 (b)

Question 4

(a) Figure Q4 (a) is a wide band pass filter that is constructed using a first order Low-Pass Filter (1st Order LP) and a first order High-Pass Filter (1st Order HP).

(i) Design a 1st Order HP for f_o @ f_L = 50 kHz and K_{LP} = 2. [6 marks]

(ii) Design a 1st Order LP for f_o @ f_H = 1 MHz and K_{HP} = 2. [6 marks]

(iii) Calculate the constant pass band gain, K_{PB} for the band pass filter and the quality factor, Q. [7 marks]

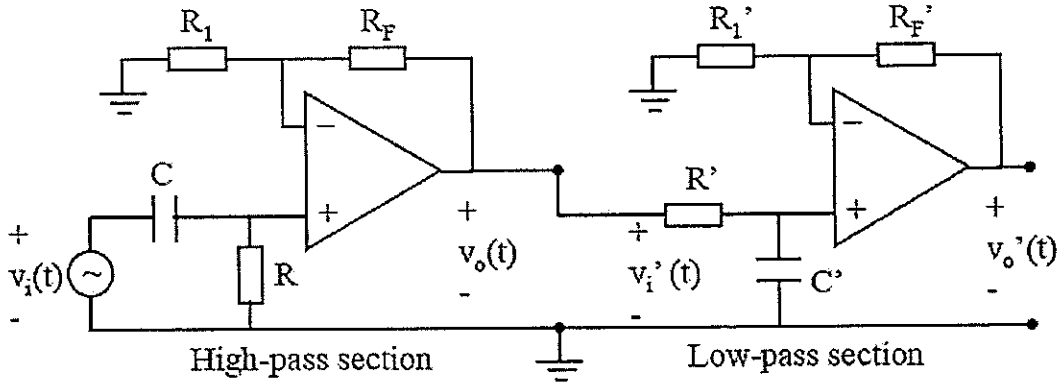

Figure Q4 (a)

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b) With reference to the non-inverting Schmitt triggers in Figure Q4 (b). Given that the $+V_{sat} = +12V$, $-V_{sat} = -10V$, $R_1 = 12\ k\Omega$, $R_f = 24\ k\Omega$. Calculate:

(i) Upper trigger level, V_{UTP}. [3 marks]

(ii) Lower trigger level, V_{LTP}. [3 marks]

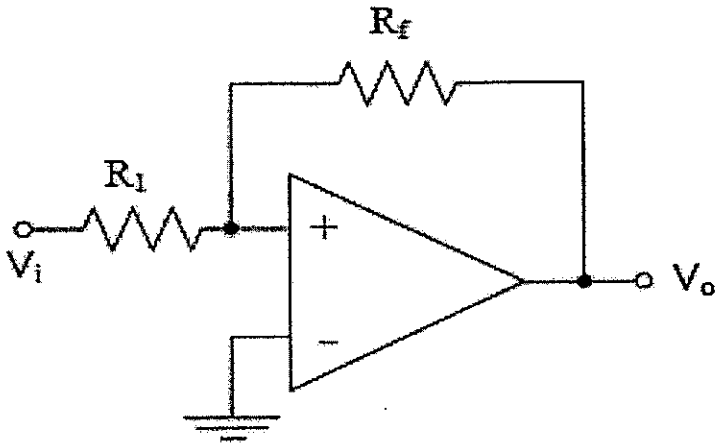

Figure Q4 (b)

End of paper